AHRI Standard 1340-2024 (I-P)

Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment

AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

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ICS Code: 23.120

Note:

This standard supersedes AHRI Standard 1340-2023 (I-P).

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Intent

This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors, federal and state regulations, and efficiency standards developed by ASHRAE 90.1, International Energy Conservation Code (IECC), Canadian Standards Association (CSA), Department of Energy (DOE), and users.

Review and Amendment

This standard is subject to review and amendment as technology advances.

2024 Edition

This edition of AHRI Standard 1340, *Performance Rating of Commercial and Industrial Unitary Air-conditioning and Heat Pump Equipment*, was prepared by Commercial Unitary Standards Technical Committee. The standard was approved by the Standards Committee on 17 June 2024.

Origin and Development of AHRI Standard 1340

The first edition of AHRI 1340-2023 (I-P) establishes the method to rate and test unitary air-cooled air conditions and heat pumps with a cooling capacity greater than or equal to 65,000 Btu/h and all water cooled and evaporatively cooled unitary products replace the IEER cooling metric with *integrated ventilation economizer and cooling metric* (*IVEC*), and adds a heat pump annualized heating metric called *integrated ventilation, heating efficiency* (*IVHE*).

The *IVEC* and *IVHE* metrics and rating and test procedures were developed as part of the Department of Energy (DOE) Appliance Standards Rulemaking Advisory Committee (ASRAC) Commercial Unitary Air Conditioners and Heat Pumps Working Group.

This standard does not replace AHRI 340/360-2022 (I-P) where IEER and COP ratings are required, but AHRI 1340 (I-P) should be used for *IVEC* and *IVHE* ratings.

AHRI Standard 1340 (I-P) covers the rating and test procedure requirements to align with the DOE ASRAC negotiation rule that developed the *IVEC* and adds a heat pump annualized heating metric called *IVHE*.

The ASRAC negotiations were limited to air cooled cooling only products and heat pump products with a capacity greater than or equal to 65,000 Btu/h up to 760,000 Btu/h, but AHRI 1340 (I-P) expands to cover the following products:

- Unitary air-cooled products with a capacity greater than or equal to 760,000 Btu/h
- Unitary heat pump products with a capacity greater than or equal to 760,000 Btu/h
- Water cooled products
- Evaporatively cooled products
- Double duct products
- Cold climate $IVHE_C$

The derivation and background of *IVEC* and *IVHE* is explained in a separate technical support document.

Summary of Changes

AHRI Standard 1340-2024 (I-P) contains the following updates to the previous edition:

- Technical corrections to tower fan and pump power adjustments
- Technical corrections to Boost 2 definition and instructions
- Technical corrections to COP2 instructions

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Commercial Unitary Standards Technical Committee Scope:

The Commercial Unitary Standards Technical Committee is responsible for the development and maintenance of AHRI standards and guidelines pertaining to commercial and industrial unitary air-conditioning and heat pump equipment including split systems, remote condensing units, and packaged equipment.

The following product types are out of scope for this STC: unitary small equipment, packaged terminal AC/HP, furnaces, variable refrigerant systems (VRF), geothermal and water source HP, single package vertical unit (SPVU), and performance rating of zoning products.

For product definitions refer to the AHRI website sector pages at www.ahrinet.org.

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PERFORMANCE RATING OF COMMERCIAL AND INDUSTRIAL UNITARY AIR-CONDITIONING AND HEAT PUMP EQUIPMENT

Section 1. Purpose

This standard establishes definitions, classifications, test requirements, rating requirements, minimum data requirements for *published ratings*, operating requirements, marking and nameplate data, and conformance conditions that include the *IVEC* and *IVHE* efficiency metrics for commercial and industrial unitary air-conditioning and heat pump equipment.

Section 2. Scope

2.1 Scope

This standard applies to factory-made commercial and industrial unitary air-conditioning and heat pump equipment as defined in Section 3.

This standard applies only to electrically operated, vapor compression refrigeration systems.

Note: Units can include furnaces that can be used for building heating and as *auxiliary heat* for heat pumps.

2.2 Exclusions

This standard does not apply to the following:

- Commercial and industrial unitary air-conditioning condensing units with a capacity greater than 135,000 Btu/h as defined in AHRI 365 (I-P)

  Note: Condensing units with a capacity ≤135,000 Btu/h are rated as a matched system with fan coil or air handler.

- Performance of fan coil units rated in accordance with AHRI 440 (I-P) or AHRI 441 (SI)
- Air-cooled unitary air-conditioners and unitary heat pumps as defined in AHRI 210/240-2023 (2020), with capacities less than 65,000 Btu/h
- Water-source heat pumps as defined in ASHRAE/AHRI/ISO 13256-1 and AHRI 600 (I-P)
- Variable refrigerant flow air-conditioners and heat pumps as defined in AHRI 1230 (I-P)
- Rating of units equipped with desuperheater/water heating devices (as defined in AHRI 470) in operation
- Units with adiabatically pre-cooled condensers

2.3 Other Applicable Standards

Commercial and industrial unitary air-conditioning and heat pump equipment can be rated using the following standards:

- Single vertical packaged air conditioners rated using AHRI 390 (I-P)
- Dedicated outdoor air systems rated with 100% outside air using AHRI 920 (I-P) or AHRI 921 (SI)
- Computer room air conditioners and condensing units serving computer rooms rated using AHRI 1360
- Performance rating of air-to-air exchangers for energy recovery ventilation equipment using AHRI 1060 (I-P) and AHRI 1061 (SI)
- Calculating the efficiency of energy recovery ventilation and how this affects efficiency and sizing of building HVAC system as defined by AHRI Guideline V (I-P)
- Packaged terminal air conditioners and heat pumps rated using AHRI 310/380

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Section 3. Definitions

All terms in this document follow the standard industry definitions in the *ASHRAE Terminology* website unless otherwise defined in Section 3.2.

3.1 Expression of Provisions

Terms that provide clear distinctions between requirements, recommendations, permissions, options, and capabilities.

3.1.1 "Can" or "cannot"

Express an option or capability.

3.1.2 "May"

Signifies a permission expressed by the document.

3.1.3 "Must"

Indication of unavoidable situations and does not mean that an external constraint referred to is a requirement of the document.

3.1.4 "Shall" or "shall not"

Indication of mandatory requirements to strictly conform to the standard and where deviation is not permitted.

3.1.5 "Should" or "should not"

Indication of recommendations rather than requirements. In the negative form, a recommendation is the expression of potential choices or courses of action that is not preferred but not prohibited.

3.2 Standard Specific Definitions

3.2.1 Air Sampling Device

A combination of *air sampling tree(s)*, conduit, fan and *aspirating psychrometer* or *dew-point hygrometer* used to determine dry-bulb temperature and moisture content of an air sample from critical locations.

3.2.1.1 Air Sampling Tree

An assembly consisting of a manifold with branch tubes with multiple sampling holes that draws an air sample from a critical location from the unit under test (such as indoor air inlet, indoor air outlet, outdoor air inlet).

3.2.1.2 Aspirating Psychrometer

An instrument used to determine the humidity of air by simultaneously measuring both the wet-bulb and dry-bulb temperatures. The difference between these temperatures is referred to as the wet-bulb depression

3.2.1.3 Auxiliary Heat

Electric, natural gas, propane, steam, or hot water heat used to supplement or be used at low ambient to assist the capacity delivered by a vapor compression heat pump cycle.

3.2.1.4 Dew-point Hygrometer

An instrument used to determine the humidity of air by detecting visible condensation of moisture on a cooled surface.

3.2.2 Barometric Relief Damper

An assembly with dampers and means to automatically set the damper position in a closed position and one or more open positions to facilitate venting directly to the outside a portion of the building air that is returning to the unit, rather than recirculating the building air to the indoor coil and back to the building.

Note: This definition is restated in Table 36.

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3.2.3 Basic Model

All units manufactured by one manufacturer within a single equipment class, having the same or comparably performing compressor(s), heat exchangers, and air moving system(s) that have a common nominal *cooling capacity*.

Note: This term is further described in Section D.2.1.

3.2.4 Coil-only Indoor Unit

An indoor unit that is distributed in commerce without an indoor blower or separate designated air mover.

Note: A *coil-only indoor unit* installed in the field relies on a separately installed furnace or modular blower for indoor air movement.

3.2.5 Commercial Unitary Air-conditioner and Heat Pump Equipment

Any air-cooled, water-cooled, or evaporatively-cooled commercial package air conditioning and heating equipment that consists of one or more factory-made assemblies that provide space conditioning.

3.2.5.1 Commercial and Industrial Unitary Air-Conditioning System

Commercial unitary air-conditioner equipment that contains one or more factory-made assemblies, that include a cooling coil, a compressor(s) and condenser combination, and can include an air moving device and a heating function. Where such equipment is provided in more than one assembly, the separate assemblies are designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies.

3.2.5.2 Commercial and Industrial Unitary Heat Pump System

Commercial unitary heat pump equipment that contains one or more factory-made assemblies, that include an indoor conditioning coil, compressor(s), and an outdoor coil(s), including means to provide a heating function and can include an air moving device and a cooling function. When such equipment is provided in more than one assembly, the separate assemblies are designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies.

3.2.6 Cooling Capacity (q_t)

The net capacity associated with the change in air enthalpy between the air entering the unit and the air leaving the unit that includes both the *latent* and *sensible capacities* expressed in Btu/h and includes the heat of circulation fan(s) and motor(s).

3.2.6.1 Latent Capacity

Capacity associated with a change in humidity ratio, expressed in Btu/h.

3.2.6.2 Sensible Capacity (q_{sci})

Capacity associated with a change in dry-bulb temperature, expressed in Btu/h.

3.2.6.3 Standard Cooling Capacity ($q_{t,A}$)

Full load *cooling capacity* at *standard rating conditions* for a unit configured in accordance with Appendix E, and when tested in accordance with the requirements of Section 5 and Section 6, expressed in Btu/h.

3.2.7 Defrost

A mode of operation for an air source heat pump where the cycle is reversed to temporarily heat the outdoor coil to remove ice that has built up when the heat pump is heating.

3.2.8 Desiccant Dehumidification Component

An assembly that reduces the moisture content of the *supply air* through moisture transfer with solid or liquid desiccants.

Note: This definition is restated in Table 36 and Table 37.

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3.2.9 Double-duct System

An air conditioner or heat pump that has the following characteristics:

- The unit is either a horizontal single package or split-system unit; or a vertical unit that consists of two components that can be shipped or installed either connected or split; or a vertical single packaged unit that is not intended for exterior mounting on, adjacent interior to, or through an outside wall.
- The unit is intended for indoor installation with ducting of outdoor air from the building exterior to and from the unit. For example, the unit, or the unit's components, or both, are non-weatherized.
- If the unit is a horizontal unit, the complete unit has a maximum height of 35in or the unit has components that do not exceed a maximum height of 35in.
- If the unit is a vertical unit, the complete split, connected, or assembled unit has components that do not exceed a maximum depth of 35 in.
- The unit has a rated *cooling capacity* greater than or equal to 65,000 Btu/h and less than 300,000 Btu/h.

See Section 5.22 for test requirements specific to externally ducted condensers.

3.2.10 Drain Pan Heater

A heater that heats the drain pan to make certain that water shed from the outdoor coil during a *defrost* does not freeze.

Note: This definition is restated in Table 37.

3.2.11 Economizer

3.2.11.1 Air Economizer

An optional feature that brings in additional outside cool air to cool the building when ambient temperature and or humidity levels are lower than the return air conditions.

Note: This definition is restated in Table 36 and Table 37.

3.2.11.2 Integrating Economizing

A control mode where both the economizer and mechanical cooling are operated to satisfy the building load. The economizer is operated at maximum capacity and the mechanical cooling is used to supplement the economizer cooling.

3.2.12 Energy Efficiency Ratio 2 (EER2)

A ratio of the *cooling capacity* to power input as specified in Section 6.2.10.

3.2.13 Evaporative Cooling

Note: These definitions are restated in Table 36.

3.2.13.1 Direct Evaporative Cooling System

A system that uses water to cool ventilation air by introducing water directly into the ventilation air.

3.2.13.2 Indirect Evaporative Cooling System

A system that uses water to cool ventilation air by evaporating the water in secondary air stream removed heat through a heat exchanger.

3.2.14 Fire, Smoke, or Isolation Damper

A damper assembly that includes a means to open and close the damper mounted at the supply or return duct opening of the equipment.

Note: This definition is restated in Table 36 and Table 37.

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3.2.15 Fresh Air Damper

An assembly with dampers and means to set the damper position in a closed and one open position so that air is drawn into the equipment when the indoor fan is operating.

Note: This definition is restated in Table 37.

3.2.16 Full Load Rated Indoor Airflow

The *standard airflow* at 100% capacity as defined by the *MII* and at the external static pressure (ESP) as determined in Section 5.17, expressed in scfm.

3.2.17 Hail Guard

A grille or comparable structure mounted to the outside of the unit covering the outdoor coil to protect the coil from hail, flying debris and damage from large objects.

Note: This definition is restated in Table 37.

3.2.18 Heating Capacity (q_H)

The capacity associated with the change in dry-bulb temperature expressed in Btu/h.

3.2.18.1 Instantaneous Heating Capacity ($q_{H,inst}$)

The net capacity before and degradation due to frost buildup on the condenser coil.

3.2.18.2 Integrated Heating Capacity ($q_{H,int}$)

The net average *heating capacity* including the impact of capacity degradation due to *defrost* of the outdoor coil, expressed in units of units of Btu/h.

3.2.19 Heating Coefficient of Performance 2 ($COP2_H$)

A ratio of the *heating capacity* in watts to the power input values in watts, as calculated in Section 6.3.14.

3.2.20 High-effectiveness Indoor Air Filtration

Indoor air filters with greater air filtration effectiveness than the *standard filter*.

Note: This definition is restated in Table 37.

3.2.21 Independent Coil Manufacturer (ICM)

A company that manufactures indoor units but does not manufacture single package units or outdoor units.

3.2.22 Indoor Single Package Air-conditioners

Non-weatherized units with factory-made assemblies of one or more evaporator fans, evaporator coils, and condensing units having means for air cooling, cleaning, dehumidification, heating with factory or field installed electric strip heaters and forced air circulation through a duct system and that can have means for humidifying and control of temperature. Included are only those units that are assembled or designed to be assembled in a single unit.

3.2.23 Integrated Ventilation, Economizing, and Cooling Efficiency (IVEC)

Total annual *cooling capacity* divided by total annual energy including mechanical cooling, economizer, cooling mode ventilation fan energy and off mode control energy and crankcase heat energy for an average building and average climate zone as defined in Section 6.2 and expressed in Btu/Wh.

3.2.24 Integrated Ventilation and Heating Efficiency (IVHE)

Total annual *heating capacity* for a heat pump including vapor compression *heating capacity* and auxiliary *heating capacity* divided by total heating model energy including mechanical vapor compression heating, *auxiliary heat* energy, heating mode ventilation fan energy and heating mode control power, and crankcase heat power as defined in Section 6.3 and expressed in Btu/Wh. $IVHE_C$ is for colder climates and uses a colder climate zone weighted average load profile and is based on ASHRAE 169 Climate Zones 5 to 8. Expressed in Btu/W·h.

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3.2.25 Low-temperature Compressor Cut-in Temperature

The maximum outdoor dry-bulb temperature where the unit's internal controls prevent the compressor(s) from starting due to the outdoor dry-bulb temperature being too low. Expressed in units of °F.

Note: See Appendix H for method of test.

3.2.26 Low-temperature Compressor Cut-out Temperature

The maximum outdoor dry-bulb temperature where the unit's internal controls stop operating compressor(s) due to the outdoor dry-bulb temperature being too low. Expressed in units of °F.

Note: See Appendix H for method of test.

3.2.27 Makeup Water

The water supplied to an evaporative cooled condenser to compensate for the water evaporated.

3.2.28 Manufacturer Instructions

3.2.28.1 Manufacturer's Installation Instructions (MII)

Manufacturer's documents that come packaged with or appear in the labels applied to the unit(s), as specified in Section 5.4.1.

3.2.28.2 Manufacturer-specified

Information provided by the manufacturer through *MII* or *STI*.

3.2.28.3 Supplemental Test Instructions (STI)

Additional instructions developed by the manufacturer and certified to the United States Department of Energy (DOE), as specified in Section 5.4.2.

3.2.29 Non-standard Ducted Condenser Fan

A higher-static condenser fan/motor assembly designed for external ducting of condenser air that provides greater pressure rise and has a higher rated motor horsepower than the condenser fan provided as a standard component with the equipment.

Note: This definition is restated in Table 36.

3.2.30 Non-standard Low-static Indoor Fan Motor

An indoor fan motor that cannot maintain ESP as high as specified in Section 5.17.1 when operating at the *full load rated indoor airflow* and that is distributed in commerce as part of an individual model within the same *basic model* that is distributed in commerce with a different motor specified for testing that can maintain the required ESP.

3.2.31 Operating Levels

3.2.31.1 Boost Heating Operating Level (B)

The *operating level* with the maximum capacity that is allowed by the controls at 17.0°F outdoor dry-bulb temperature, with a capacity at 17.0°F outdoor dry-bulb temperature that is greater than the capacity of the *high heating operating level* at 17.0°F. See Section 6.3.6 for requirements.

3.2.31.2 Boost 2 Heating Operating Level (B2)

An operating level allowed by the controls at 5.0°F outdoor dry-bulb temperature with a capacity at 5.0°F outdoor dry-bulb temperature that is less than or equal to the maximum capacity allowed by the controls at 5.0°F outdoor dry-bulb temperature and greater than the capacity of:

(a) the *boost heating operating level* at 5.0°F outdoor dry-bulb temperature, if there is an operating level that meets the definition for *boost heating operating level* specified in Section 3.2.31.1; or

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(b) the *high heating operating level* at 5.0°F outdoor dry-bulb temperature, if there is not an operating level that meets the definition for *boost heating operating level* specified in Section 3.2.31.1.

See Section 6.3.6 for requirements.

3.2.31.3 High Heating Operating Level (H)

The *operating level* with the maximum capacity that is allowed by the controls at 47.0°F outdoor dry-bulb temperature. See Section 6.3.6 for requirements.

3.2.31.4 Low Heating Operating Level (L)

The *operating level* with the minimum capacity that is allowed by the controls at 47.0°F outdoor dry-bulb temperature. See Section 6.3.6 for requirements.

3.2.31.5 Medium Heating Operating Level (M)

An *operating level* allowed by the controls at 47.0°F outdoor dry-bulb temperature with a capacity at 47.0°F outdoor dry-bulb temperature that is greater than the capacity of the *low heating operating level* at 47.0°F outdoor dry-bulb temperature and less than the capacity of the *high heating operating level* at 47.0°F outdoor dry-bulb temperature. See Section 6.3.6 for requirements.

3.2.31.6 Operating Level

Is determined by the number of compressors operating, the modulation level of each operating compressor, and the indoor fan speed. The modulation level of a single compressor is determined by the speed, duty cycle, vapor injection setting, and state of any other operating parameters that affect the continuous capacity of the compressor at a single set of operating conditions.

3.2.32 Outdoor Unit Manufacturer (OUM)

A manufacturer of single package units, outdoor units, and indoor units or outdoor units, or both.

3.2.33 Part Load Rated Indoor Airflow (Q_{PL})

The *standard airflow* at the *manufacturer-specified* part-load ratings conditions and at the ESP as determined in Section 5.17. This can be different for each part-load rating point.

3.2.34 Power Correction Capacitor

A capacitor that increases the power factor measured at the line connection to the equipment.

Note: This definition is restated in Table 37.

3.2.35 Powered Exhaust Air Fan

A fan that transfers directly to the outside a portion of the building air that is returning to the unit, rather than allowing it to recirculate to the indoor coil and back to the building.

Note: This definition is restated in Table 36.

3.2.36 Powered Return Air Fan

A fan that draws building air into the equipment for exhausting or recirculation.

Note: This definition is restated in Table 36.

3.2.37 Process Heat Recovery, Reclaim, or Thermal Storage Coil

A heat exchanger located inside the unit that conditions the equipment's *supply air* using energy transferred from an external source using a vapor, gas, or liquid.

Note: This definition is restated in Table 36 and Table 37.

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3.2.38 Published Rating

A statement of the assigned values of those performance characteristics, under stated *rating conditions*, where a unit can be chosen to fit the application. These values apply to all units of the same nominal size and type (identification) produced by the same manufacturer. This includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated *rating conditions*.

3.2.38.1 Application Rating

A rating based on tests performed at *rating conditions* other than *standard rating conditions*.

3.2.38.2 International Ratings

A rating based on tests performed at *international rating conditions* as listed in Table 43.

3.2.38.3 Standard Rating

A rating based on tests performed at *standard rating conditions*.

3.2.39 Rating Conditions

Any set of operating conditions where a single level of performance results and causes only that level of performance to occur.

3.2.39.1 International Rating Conditions

Rating conditions used as the basis of comparison for performance characteristics for products sold outside North America as defined in Table 43.

3.2.39.2 Part Load Rating Conditions

Rating conditions used as the basis of calculating the *IVEC* and *IVHE* annualized efficiency metrics as defined in Section 6.

3.2.39.3 Standard Rating Conditions

Rating conditions used as the basis of comparison for performance characteristics as defined in Table 7.

3.2.40 Rating Power

Electrical power used to deliver capacity and during off modes of operation.

3.2.40.1 Crankcase Heat Power (P_{CCH})

The power used to keep the temperature of the compressor lubrication oil warm enough to prevent migration of the refrigerant to the oil when the compressor is off, expressed in W. See Section E.10 for requirements.

3.2.40.2 Compressor Power (P_C)

The power needed for all compressors, including any inverter losses, variable-speed drive losses, and auxiliary power required for compressor operation, expressed in W. This can include *crankcase heat power*. See Section E.10 for requirements.

3.2.40.3 Condenser Section Power (P_{CD})

The power needed for all fans, pumps, and other condenser section components, including any inverter or variable-speed drive losses, expressed in W. See Section E.10 for requirements.

3.2.40.4 Controls Power (P_{CT})

The power of all controls and all auxiliary loads that are not part of the *compressor power*, *condenser section power*, or *indoor fan power*, expressed in W. This can include *crankcase heat power*. See Section E.10 for requirements.

3.2.40.5 Indoor Fan Power (P_{IF})

The power needed for the fans, motors, belt drives, and variable-speed drive losses for all indoor fans, expressed in W. See Section E.10 for requirements.

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3.2.41 Refrigerant Reheat Coil

A heat exchanger located downstream of the indoor coil that heats the *supply air* during cooling operation using high pressure refrigerant to increase the ratio of moisture removal to *cooling capacity* provided by the equipment.

Note: This definition is restated in Table 36 and Table 37.

3.2.42 Single Package Air-conditioner

A *single package system* with factory-made assemblies of one or more evaporator fans, evaporator coils, and condensing sections having means for air cooling, cleaning, dehumidification, heating with factory or field installed electric strip heaters and forced air circulation through a duct system and that can have means for humidifying and control of temperature. These units do not have gas heat and are not heat pumps.

3.2.43 Single Package Heat Pumps

A *single package system* that can both cool and heat with the refrigeration system that can have provision for supplementary electric, hot water, or steam heat that are factory-made assemblies of one or more evaporator fans, evaporator coils, and condensing sections having means for air cooling, heating, cleaning, dehumidification, and forced air circulation through a duct system and that can have means for humidifying and control of temperature, with provision for modifying the performance so that either heating or cooling and dehumidification can be produced.

3.2.44 Single Package System

Any *commercial unitary air-conditioning system* or *commercial unitary heat pump system* that has the means for air circulation and heat removal, air cleaning, and the controls thereof, that are assembled or designed to be assembled within a single factory-made enclosure.

3.2.45 Sound Trap

An assembly of structures that the *supply air* passes through before leaving the equipment or that the return air from the building passes through immediately after entering the equipment where the sound insertion loss is at least 6 dB for the 125 Hz octave band frequency range.

Note: Can be called sound attenuator.

Note: This definition is restated in Table 36.

3.2.46 Split System

Any *commercial and industrial unitary air-conditioning system* or *commercial and industrial unitary heat pump system* that has one or more of the major assemblies separated from the others.

3.2.47 Standard Energy Efficiency Ratio

A ratio of the capacity to power input value obtained at *standard rating conditions*.

3.2.48 Standard Air

Air having a mass density of 0.075 lb of dry air per ft^3.

3.2.49 Standard Airflow

The volumetric flowrate of air converted to *standard air* conditions expressed in scfm.

3.2.50 Standard Filter

The filter with the lowest filter effectiveness that is distributed in commerce with a model, as specified in Section 5.6.

3.2.51 Steam or Hydronic Heat Coils

Coils used to provide supplemental heating.

Note: This definition is restated in Table 36 and Table 37.

3.2.52 Supply Air

Air delivered by a unit to the conditioned space.

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3.2.53 UV Lights

A lighting fixture and lamp mounted to shine light on the indoor coil, that emits ultraviolet light to inhibit growth of organisms on the indoor coil surfaces, the condensate drip pan, and/other locations within the equipment.

Note: This definition is restated in Table 37.

3.2.54 Ventilation Air

The minimum amount of outdoor air required for the purpose of controlling air contaminant levels in buildings.

3.2.55 Ventilation Energy Recovery System (VERS)

An assembly that pre-conditions outdoor air entering equipment through direct or indirect thermal, or moisture exchange with the unit's exhaust air, or both, that is defined as the building air being exhausted to the outside from the equipment.

Note: This definition is restated in Table 36 and Table 37.

3.2.56 Year-round Single Package Air-conditioner

A *single package air-conditioner* that includes gas heating.

3.2.57 Year-round Single Package Heat Pump

A *single package heat pump* that includes gas heating.

Note: Can be referred to as dual fuel equipment.

Section 4. Classifications

Commercial and industrial unitary air-conditioning and heat pump equipment within the scope of this standard shall be classified as shown in Table 1 and Table 2.

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Table 1 Classification of Commercial and Industrial Unitary Air-conditioning Equipment

Designation	AHRI Type[1,2]	Arrangement – Indoor (ID)	Arrangement – Outdoor (OD)
Single package and indoor package air-conditioner	SP-A[3, 4] SP-E[3, 4] SP-W[4, 7]	—	ELECTRIC HEAT[5] OD FAN or PUMP ID FAN COMPRESSOR EVAPORATOR CONDENSER
Year-round single package air-conditioner	SPY-A[3, 4] SPY-E[3, 4] SPY-W[4, 7]	—	GAS HEAT[6] OD FAN or PUMP ID FAN COMPRESSOR EVAPORATOR CONDENSER
Air-conditioner with remote condenser	RC-A[3] RC-E[3] RC-W[7]	ID FAN EVAPORATOR ELECTRIC HEAT[5]	OD FAN or PUMP COMPRESSOR[8] CONDENSER
Split system air-conditioners: condensing unit, coil alone	RCU-A-C[3] RCU-E-C[3] RCU-W-C[7]	EVAPORATOR	OD FAN or PUMP COMPRESSOR CONDENSER
Split system air-conditioners: condensing unit, coil and fan	RCU-A-CB[3] RCU-E-CB[3] RCU-W-CB[7]	ID FAN EVAPORATOR ELECTRIC HEAT[5]	OD FAN or PUMP COMPRESSOR CONDENSER
Year-round *split system* condensing unit, coil and fan	RCUY-A-CB[3] RCUY-E-CB[3] RCUY-W-CB[7]	GAS HEAT[6] ID FAN EVAPORATOR	OD FAN or PUMP COMPRESSOR CONDENSER

Notes:

1. A suffix of "-O" following any of the above classifications indicates equipment not intended for use with field-installed duct systems.
2. "-A" indicates air-cooled condenser, "-E" indicates evaporatively-cooled (does not apply to evaporative pre-cooled) condenser and "-W" indicates water-cooled condenser.
3. For *double-duct systems*, insert “-DD” at the end, and outdoor arrangement moves from outdoor side to indoor side.
4. Components can be installed indoors as well in accordance with *MII*.
5. Optional component.
6. Can be any other heat source except for electric strip heat.
7. For water-cooled products, outdoor arrangement can move from outdoor side to indoor side.
8. Can be installed with either the indoor or the outdoor unit.

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Table 2 Classification of Commercial and Industrial Unitary Heat Pump Equipment

Designation	AHRI Type[1]	Arrangement - Indoor (ID)	Arrangement – Outdoor (OD)
Single package heat pump	HSP-A[2]	—	ELECTRIC HEAT[3] OD FAN or PUMP ID FAN COMPRESSOR EVAPORATOR CONDENSER
Year-round single package heat pump	HSPY-A	—	GAS HEAT[4] OD FAN or PUMP ID FAN COMPRESSOR EVAPORATOR CONDENSER
Heat pump with remote outdoor coil	HRC-A-CB[2]	ID FAN EVAPORATOR COMPRESSOR	OD FAN or PUMP CONDENSER
Split system heat pump with remote outdoor coil without indoor fan	HRC-A-C[2]	EVAPORATOR COMPRESSOR	OD FAN or PUMP CONDENSER
Split system heat pump with coil blower	HRCU-A-CB[2]	ELECTRIC HEAT[3] ID FAN EVAPORATOR	OD FAN or PUMP COMPRESSOR CONDENSER

Notes:
1. A suffix of "-O" following any of the above classifications indicates equipment not intended for use with field-installed duct systems.
2. For *double-duct systems*, append “-DD”, and outdoor arrangement moves from outdoor side to indoor side.
3. Optional component.
4. Can be other heat sources.

Section 5. Test Requirements

5.1 Summary

All *standard ratings* shall be in accordance with the test methods and procedures as described in this standard and the appendices.

Units shall be tested in accordance with ASHRAE 37 as amended by this section and Appendix E.

5.2 Optional System Features

Use Appendix D to determine the optional system features to be included during the tests and the settings for each optional system feature during the tests.

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5.3 Secondary Verification

Secondary verification measurements of *cooling* and *heating capacity* (if applicable) shall be conducted in accordance with Section E.6 of this standard.

5.4 Instructions

5.4.1 Manufacturer's Installation Instructions (MII)

Units shall be installed in accordance with the *MII*, as defined in Section 3.2.28.1. Online manuals can be used if referenced on the unit label or in the documents that come packaged with the unit.

All references to "manufacturer's instructions," "manufacturer's published instructions," "manufacturer's published recommendations," "manufacturer installation and operation manuals," "installation instructions" and other referenced information from the manufacturer means *MII*.

The *MII* include certification reports provided to regulatory bodies by the manufacturer. The *MII* certified parameters in the *MII* certification reports shall not deviate from the *MII*.

5.4.2 Supplemental Test Instructions (STI)

STI are defined in Section 3.2.28.2 and shall include both:

1) all instructions that do not deviate from *MII* but provide additional specifications for test standard requirements that can have more than one option
2) all deviations from *MII* necessary to comply with steady state requirements

STI shall provide steady operation that matches to the extent achievable the average performance that can be obtained without deviating from the *MII*. *STI* shall not include instructions that deviate from *MII* other than those described in Section 5.4.2(2).

5.4.3 Conflicting Instructions

In the event of conflicting instructions regarding the set-up of the unit under test, excluding charging instructions for *split systems* described in Section 5.4.4, priority shall be given to installation instructions that appear on the unit's label over installation instructions that are shipped with the unit.

5.4.4 Instructions for Split Systems

In the event of conflicting charging instructions for *split systems*, priority shall be given to the installation instructions that are shipped with the unit over the installation instructions that appear on the unit's label. For *split systems* other than mix-matched systems described in Section 5.4.5, if the *MII* for the components conflict, priority shall be given to the outdoor unit instructions over the indoor unit instructions, except for provisions regarding setting indoor airflow and ESP. For setting indoor airflow and ESP for such a *split system*, priority shall be given to the indoor unit instructions over the outdoor unit instructions.

5.4.5 Mix-Matched Split Systems

The following provisions apply for systems consisting of an *OUM* outdoor unit and an *ICM* indoor unit. If instructions for the two units differ, priority shall be given to the *ICM MII*. If instructions are provided only with the outdoor unit or are provided only with an *ICM* indoor unit, then use the provided instructions.

5.5 Break-in

Conduct a compressor break-in period prior to conducting the test if there is a *manufacturer-specified* break-in period. Conduct the break-in period using the *manufacturer-specified* duration and conditions; however, the duration shall not exceed twenty hours and the outdoor temperature shall not exceed 115°F. When there is a *manufacturer-specified* break-in period, each compressor of the unit shall undergo this break-in period. Testing shall not commence until the *manufacturer-specified* break-in period is completed.

5.6 Indoor Air Filter

Units with integral fans shall be tested with the *standard filter* installed.

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The *standard filter* is the indoor air filter with the lowest filter efficiency that is distributed in commerce with a model. If the manufacturer does not specify what filter option has the lowest level of filtration in *MII* or marketing materials for the model, then the *standard filter* shall be the filter designated as the "default" or "standard" filter in the marketing materials for the model. If the manufacturer does not specify a default filter option or the filter option that has the lowest filtration level, then the *standard filter* shall be any filter shipped by the manufacturer.

For units with integral fans distributed in commerce without a filter, follow the instructions in Section 5.17.1.2.

Coil-only indoor units shall be tested without a filter installed.

5.7 Recirculated Indoor Air

Use 100% recirculated indoor air in all tests.

5.8 Test Unit Duct Installation Requirements

ASHRAE 37 duct requirements and the requirements of Appendix E shall be followed. Furthermore, the test apparatus including the interconnecting ductwork shall be insulated to have a minimum R-value of 13 $ft^2 \cdot °F$ h/Btu.

Calculate duct losses using conduction factors, inside air and outside ambient temperature difference, and the total duct surface area between the unit and the temperature measurement location. Ducts that are exposed to multiple ambient temperatures shall be divided into zones and each zone calculated separately.

5.9 Defrost Controls

Defrost controls shall be left at manufacturer's factory settings if the *MII* provided with the equipment do not specify otherwise. To facilitate testing of any unit, the manufacturer shall provide information and any necessary hardware to manually initiate a *defrost* cycle.

5.10 Auxiliary Heat

Do not test with operation of *auxiliary heat* or any heating components other than the reverse cycle heat pump functionality.

5.11 Head Pressure Control

For units with condenser head pressure controls, the head pressure controls shall be enabled and operated in automatic mode. Set head pressure controls as specified by the *MII*. If there are not any such instructions, use the as-shipped setting. If this results in unstable operation (outside test tolerances specified in Section 5.25) and testing requirements cannot be met, then the procedures in Section E.7 shall be used.

5.12 Line Length for Split Systems

All *standard ratings* for equipment where the outdoor section is separated from the indoor section shall be determined with at least 25 ft of interconnection tubing on each line of the size specified in the *MII*.

Use the absolute minimum length of tubing necessary to physically connect the system, subject to the minimum specified length, but use not less than 25 ft. Such equipment where the interconnection tubing is furnished as an integral part of the machine and not intended to be cut to length in accordance with the *MII*, shall be tested with the complete length of tubing furnished, or with 25 ft of tubing, whichever is greater. At least 10 ft of the interconnection tubing shall be exposed to the outside conditions. The line sizes, insulation, and details of installation shall be in accordance with the *MII*.

If more than 25 ft of tubing is used, the applicable *cooling capacity* correction factor in Table 3 shall be multiplied by the measured full load *cooling capacity* to determine the final full load *cooling capacity*. Do not use the *cooling capacity* correction factors when determining part-load *cooling capacity*.

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Table 3 Refrigerant Line Length Correction Factors

Tubing length (X) Beyond the Required 25 ft of Tubing, ft	Cooling Capacity Correction Factor
$3.3 < X \leq 20$	1.01
$20 < X \leq 40$	1.02
$40 < X \leq 60$	1.03

Note: There is not any *heating capacity* correction for heat pumps.

5.13 Refrigerant Charging

5.13.1 Conditions and Criteria

Unless the unit does not require charging (per Section 5.13.5), use the test or operating conditions specified in the *MII* for charging. If the *MII* do not specify a test or operating conditions for charging or there are not any *MII*, charging shall be conducted at *standard rating conditions* in cooling mode. If the *MII* contain two sets of refrigerant charging criteria, one for field installation and one for lab testing, use the field installation criteria. Perform charging of refrigerant blends only with refrigerant in the liquid state.

5.13.2 Parameter Ranges

If the *MII* give a *manufacturer-specified* range for a charging parameter (for example, superheat, subcooling, or refrigerant pressure) the average of the range shall be used to determine the refrigerant charge.

5.13.3 No Manufacturer Instructions

If there are not any *MII* or the *MII* do not provide parameters and target values, or both, set superheat to a target value of 12°F for fixed orifice systems or set subcooling to a target value of 10°F for expansion valve systems.

5.13.4 Conflicting Information

In the event of conflicting information between charging instructions, use the instruction priority order indicated in Section 5.4. Conflicting information is defined as multiple *manufacturer-specified* conditions given for charge adjustment where all *manufacturer-specified* conditions cannot be met. If such instances of conflicting information occur within the highest-ranking set of instructions where refrigerant charging instructions are provided, follow the hierarchy in Table 4, for fixed orifice or expansion valve, as applicable, unless the manufacturer specifies a different priority in the outdoor unit installation instructions. Unless the *MII* specify a tighter charging tolerance, the tolerances specified in Table 4 shall be used.

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Table 4 Tolerances for Charging Hierarchy

Fixed Orifice			Expansion Valve		
Priority	**Parameter**	**Tolerance**	**Priority**	**Parameter**	**Tolerance**
1	Superheat	± 2.0°F	1	Subcooling	± 2.0°F
2	High side pressure or saturation temperature	± 4.0 psi or ± 1.0°F	2	High side pressure or saturation temperature	± 4.0 psi or ± 1.0°F
3	Low side pressure or saturation temperature	± 4.0 psi or ± 1.0°F	3	Low side pressure or saturation temperature	± 2.0 psi or ± 0.8°F
4	Low side temperature	± 2.0°F	4	Approach temperature[1]	± 1.0°F
5	High side temperature	± 2.0°F	5	Charge weight	± 1% of nominal charge or 2.0 oz., whichever is greater
6	Charge weight	± 1% of nominal charge or 2.0 oz., whichever is greater	—	—	—

Note:

1. Approach temperature means the refrigerant liquid temperature at the outdoor liquid service port minus the outdoor ambient temperature.

5.13.5 Single Package Unit

5.13.5.1 Install Refrigerant Line Pressure Gauges

Install one or more refrigerant line pressure gauges during the setup of the unit unless either of the following conditions are met:

1) the *MII* indicate that pressure gauges shall not be installed
2) charging is based only on parameters, such as charge weight, that do not require measurement of refrigerant pressure

Use methods for installing pressure gauge(s) at the required location(s) as indicated in *MII* if specified. Install pressure gauges depending on the parameters used to verify or set charge, as described in the following paragraphs.

5.13.5.2 Pressure Gauge on Liquid Line

Install a pressure gauge at the location of the service connections on the liquid line if charging is based on subcooling, or high side pressure or corresponding saturation or dew point temperature.

5.13.5.3 Pressure Gauge on Suction Line

Install a pressure gauge at the location of the service connection on the suction line if charging is based on superheat, or low side pressure or corresponding saturation or dew point temperature.

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5.13.6 No Further Changes

The refrigerant charge obtained as described in this section shall then be used to conduct all tests used to determine performance. All tests shall run until completion without further modification. If measurements indicate that refrigerant charge has leaked during the test, repair the refrigerant leak, repeat any necessary set-up steps, and repeat all tests.

5.14 Test Unit Location

5.14.1 Air-Cooled and Evaporatively-Cooled Equipment

For testing *split systems*, the indoor unit shall be located in the indoor test room (in other words, the test chamber maintained at the air conditions specified for return indoor air). A remote condenser or condensing unit shall be located in the outdoor test room (in other words, the test chamber maintained at the air conditions specified for outdoor ambient air), unless the remote condenser or condensing unit is designed and marketed for indoor installation (for example, *double-duct systems*), then the indoor remote condenser or condensing unit shall be located in the indoor test room. For testing single package units, the unit shall be located in the outdoor test room unless the unit is designed and marketed for indoor installation (for example, *double-duct systems*), then the unit shall be located in the indoor test room.

5.14.2 Water-Cooled Equipment

The unit (including both units for *split systems*) shall be located in the indoor test room.

5.15 Voltage and Frequency

Standard rating tests shall be performed at the nameplate rated voltage(s) and frequency.

For air-conditioners and heat pumps with dual nameplate voltage ratings, *standard rating* tests shall be performed at both voltages, or at the lower of the two voltages, if only a single *standard rating* is published.

Operating requirements tests shall be performed at the voltage(s) and frequency(ies) specified for each operating requirements test in Section 8.

5.16 Instrumentation

5.16.1 Induction Watt-hour Meter

When testing air conditioners and heat pumps having a variable speed drive, an induction watt-hour meter shall not be used.

5.16.2 Atmospheric Pressure

Atmospheric pressure measuring instruments shall be accurate to within ± 0.5% of the reading.

5.16.3 Electrical Frequency

Measurement devices used to measure electrical frequency shall be accurate to within ± 0.2 Hz.

5.17 Indoor Air External Static Pressure for Testing

5.17.1 Units with Integral Indoor Fans

5.17.1.1 Full-load Cooling Tests

Use the external static pressure specified in Table 5 for all tests that use the full-load cooling airflow.

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Table 5 Full-load Cooling External Static Pressure

Full-load Cooling Capacity Measured in Section 6.2.6, kBtu/h	Testing with Economizer Dampers Present in the Airstream (in-H_2O)	Testing without Economizer Dampers Present in the Airstream (in-H_2O)
>0 and <65[1]	0.50	0.60
≥65 and <135	0.75	0.85
≥135 and <280	1.00	1.10
≥280	1.50	1.60

Note:
1. Only applicable for evaporatively and water-cooled units.

5.17.1.2 Testing Without a Filter

For units distributed in commerce without a filter, an additional static pressure allowance as specified in Equation 1 shall be added to the minimum static pressure shown in Table 5. The additional static pressure shall be based on the filter face area, as defined in the *MII*, and the rated full-load cooling airflow. For units that do not specify a filter face area or units where a 2 in filter rack is not an option, the face area of the evaporator shall be used. For tests that use an airflow different than the full-load cooling airflow, the additional static pressure allowance shall be reduced in accordance with Section 5.17.1.3.

$$ESP_{filter} = 0.000108 \times \left(\frac{Q_{FL}}{A_{ft}}\right)^{1.3} \quad \textbf{1}$$

Where:

ESP_{filter} = additional static pressure allowance, in H_2O

Q_{FL} = Rated full-load cooling *standard airflow*, scfm

A_{ft} = Filter face area, ft^2.

5.17.1.3 Tests That Do Not Use the Full-load Cooling Airflow

When conducting tests where the *manufacturer-specified* fan control settings, or rated airflows are different than for the full-load cooling test, or both, calculate adjusted ESP requirements using Equation 2.

$$ESP_{adj} = ESP_{FL} \times \left(\frac{Q_{dif}}{Q_{FL}}\right)^{2} \quad \textbf{2}$$

Where:

ESP_{adj} = Adjusted ESP requirement at airflow other than full-load cooling airflow, in H_2O

ESP_{FL} = ESP requirement at full-load cooling airflow determined in Section 5.17, in H_2O

Q_{dif} = Measured airflow other than full-load cooling airflow, scfm

Q_{FL} = Measured full-load cooling airflow, scfm

5.17.1.4 Split Between Return and Supply Static Pressure

The return static pressure shall be 20% to 25% of total static pressure (TSP), unless the return static pressure is greater than 25% of TSP without inlet restriction, mixers, elbows, transitions, or sampling devices installed on the inlet duct. Use Section E.11 to set the static pressure split.

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5.17.2 Coil-only Indoor Units

For *coil-only indoor units*, the pressure drop across the indoor assembly shall not exceed 1.00 in H_2O for the full-load cooling test.

5.18 Indoor Airflow Target Values

5.18.1 Standard Airflow

All airflows, including those used for determining capacity, shall be expressed in terms of *standard airflow*. When converting measured airflow to *standard airflow*, the conversion shall be based on the air density at the airflow test measurement station.

5.18.2 Minimum Airflow

The indoor airflow in scfm for all tests shall not be less than the minimum indoor airflow determined in Equation 3.

$$\text{Minimum indoor airflow} = 0.008 \times q_{T,A} \quad \textbf{3}$$

Where:

$q_{T,A}$ = The *cooling capacity* measured for the full-load cooling test in Section 6.2.5, Btu/h

Note: The 0.008 is based on 24% *ventilation air* and 400 cfm/ton.

5.18.3 Units with Integral Indoor Fans

5.18.3.1 Full-load Cooling

For the full-load cooling test (except for *coil-only indoor units*), use the cooling *full load rated indoor airflow*. If there is not a cooling *full load rated indoor airflow*, use a value of 400 scfm per ton of rated *cooling capacity*.

5.18.3.2 Part-load Cooling

For part-load cooling tests, use the *part load rated indoor airflow* for that test point. If there is not a *part load rated indoor airflow* for the test point, use the airflow that results from using the *manufacturer-specified* part-load fan control settings for that test at the ESP requirement determined in accordance with Section 5.17. If *part load rated indoor airflow* and *manufacturer-specified* part-load cooling fan control settings are not provided for the test point, but the *MII* describe how to obtain steady-state part-load cooling or heating operation (for example, using thermostat or other control system input) that results in an automatic adjustment to airflow, use those instructions. If none of this information is accessible, for part-load cooling tests use the cooling full load rate indoor airflow.

Note: This standard does not include any separate airflow-setting provisions for units with control systems designed to vary the indoor air volume and refrigeration capacity at a controlled discharge air temperature and static pressure as a means of providing space temperature control to independent multiple spaces with independent thermostats. All units are now tested using the *manufacturer-specified part load rated indoor airflow*.

5.18.3.3 Heating

For each heating test (except for *coil-only indoor units*), use the *manufacturer-specified* airflow for the test. If there is not a *manufacturer-specified* airflow for the test, use the airflow that results from using the *manufacturer-specified* heating fan control settings at the adjusted ESP requirement determined in accordance with Section 5.17. If there is not a *manufacturer-specified* airflow and not any *manufacturer-specified* heating fan control settings for the test but the *MII* or *STI* describe how to obtain steady-state heating operation (for example, using thermostat or other control system input) that results in an automatic adjustment to airflow, use those instructions. If none of this information is accessible, use the cooling *full load rated indoor airflow* for the test.

Note: See Section 6.3.6 for airflow requirements for each heating *operating level*.

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5.18.4 Coil-only Indoor Units

5.18.4.1 Full-load Cooling

For full-load cooling tests of *coil-only indoor units*, the indoor airflow shall be the lesser of the cooling *full load rated indoor airflow*; or the airflow equal to 450 scfm per ton of rated *cooling capacity*. If there is not a *full load rated indoor airflow*, use a value of 400 scfm per ton of rated *cooling capacity*.

5.18.4.2 All Tests Other than Full-load Cooling Tests

For all tests of *coil-only indoor units* other than full-load cooling tests, determine the target indoor airflow as follows:

If there is not a *manufacturer-specified* airflow for the test, use the measured full-load cooling airflow.

If the *manufacturer-specified* airflow for the test is greater than the measured full-load cooling airflow, use the measured full-load cooling airflow.

If the *manufacturer-specified* airflow for the test is less than or equal to the measured full-load cooling airflow and greater than or equal to the 67.0% of the measured full-load cooling airflow, use the manufacturer-specified airflow for the test.

If the *manufacturer-specifie*d airflow for the test is less than 67.0% of the measured full-load cooling airflow, use 67.0% of the measured full-load cooling airflow.

5.19 Setting Indoor External Static Pressure and Airflow for Units with Integral Fans

5.19.1 Conditions for Setting Airflow Before Test

For each test, set indoor airflow while operating the unit at the *rating conditions* specified for the test. After setting the airflow, adjustments shall not be made to the fan control settings during the test.

5.19.2 Tolerances

All tolerances for airflow and ESP specified in Section 5.19 for setting airflow and ESP are condition tolerances that apply for each test. Specifically, the average value of a parameter measured over the course of the test shall vary from the target value by not more than the condition tolerance. Operating tolerances for ESP and nozzle pressure drop are specified in Section 5.25.

5.19.3 Full-load Cooling Test Static and Airflow

5.19.3.1 First Setting and Adjustment

Operate the unit using the *manufacturer-specified* fan control settings. If there are not any *manufacturer-specified* fan control settings, use the as-shipped fan control settings. Adjust the airflow-measuring apparatus to maintain total ESP within -0.00/+0.05 in H_2O of the requirement specified in Section 5.17 and to maintain the airflow within ± 3% of the cooling *full load rated indoor airflow*.

5.19.3.2 If Above Tolerance

If total ESP or airflow are higher than the tolerance range, adjust the fan control settings (for example, lower fan speed) to maintain both total ESP and airflow within tolerance. If ESP or airflow are higher than the tolerance range at the lowest fan control setting (for example lowest fan speed), adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with a total ESP as close as achievable to the minimum requirement specified in Section 5.17.

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5.19.3.3 If Below Tolerance

If total ESP or airflow are lower than the tolerance range, adjust the fan control settings (for example, higher fan speed) to maintain both ESP and airflow within tolerance. If total ESP or airflow are lower than the tolerance range at the maximum fan control setting (for example, highest fan speed) and the motor is not a *non-standard low-static indoor fan motor*, adjust the airflow-measuring apparatus to maintain total ESP within tolerance and operate with an airflow as close as achievable to the *manufacturer-specified* value. Use the measured lower airflow as the target airflow for all subsequent tests that call for the cooling *full load rated indoor airflow*.

If the motor is a *non-standard low-static indoor fan motor*, use the maximum fan speed that does not overload the motor or motor drive and adjust the airflow-measuring apparatus to maintain airflow within tolerance, and operate with an ESP as close as achievable to the minimum requirement specified in Section 5.17.

5.19.3.4 If Cannot Meet Tolerance

For two adjacent fan control settings, if the lower setting is too low (such as total ESP or airflow are lower than the tolerance range) and the higher setting is too high (such as total ESP or airflow are higher than the tolerance range), use the higher fan control setting. At this higher fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with an ESP as close as achievable to the minimum requirement specified in Section 5.17.

5.19.3.5 Situations Without Condition Tolerances

If the total ESP measured after setting airflow exceeds the minimum total ESP requirement by more than 0.05 in H_2O because the ESP and airflow requirements cannot be simultaneously met there is not a condition tolerance for total ESP.

If an airflow less than 97% of the cooling *full load rated indoor airflow* is used for the full-load cooling test in Section 5.19.3.3, there is not a condition tolerance for airflow.

5.19.4 All Tests Other Than Full-load Cooling Tests

5.19.4.1 Same Airflow as Full-load Cooling Airflow

For tests where the *manufacturer-specified* airflow is the same as the cooling *full load rated indoor airflow*, and for tests where there is not a *manufacturer-specified* airflow, use the fan control settings used for the full-load cooling test. Adjust the airflow-measuring apparatus to maintain the airflow within ± 3% of the measured full-load cooling airflow without regard to the resulting total ESP. Changes shall not be made to the fan control settings for the test.

5.19.4.2 Different Airflow Than Full-load Cooling Airflow

For tests where the *manufacturer-specified* airflow differs from the cooling *full load rated indoor airflow*, use the provisions described in Section 5.19.4.2.1 through Section 5.19.4.2.7.

5.19.4.2.1 First Setting

Operate the system using the *manufacturer-specified* fan control settings for that test condition. If there are not any *manufacturer-specified* fan control settings for the test, use the fan control settings for the full-load cooling test. If there are not any *manufacturer-specified* fan control settings for any tests, use the as-shipped fan control settings.

5.19.4.2.2 First Adjustment

Adjust the airflow-measuring apparatus to maintain total ESP within 0.00/+0.05 in H_2O of the adjusted total ESP requirement determined in accordance with Section 5.17 and maintain airflow within ± 3% of the *manufacturer-specified* airflow.

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5.19.4.2.3 If Above Tolerance

If total ESP or airflow are higher than the tolerance range, adjust the fan control settings (for example, lower fan speed) to maintain both total ESP and airflow within tolerance, if this can be achieved. If ESP or airflow are higher than the tolerance range at the lowest fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with a total ESP as close as achievable to the adjusted ESP requirement.

5.19.4.2.4 If Below Tolerance

If total ESP or airflow are lower than the tolerance range, adjust the fan control settings (for example, higher fan speed) to maintain both total ESP and airflow within tolerance (if this can be achieved, but without adjusting sheaves and without exceeding the final fan control settings used for the full-load cooling test). If this cannot be achieved, adjust the airflow-measuring apparatus to maintain total ESP within tolerance and operate with an airflow as close as achievable to the *manufacturer-specified* value.

5.19.4.2.5 If Cannot Meet Tolerance

For two adjacent fan control settings, if the lower setting is too low (such as total ESP or airflow are lower than the tolerance range) and the higher setting is too high (such as total ESP or airflow are higher than the tolerance range), use the higher fan control setting. At this higher fan control setting, adjust the airflow-measuring apparatus to maintain airflow within tolerance and operate with a total ESP as close as achievable to the minimum requirement specified in Section 5.17.

5.19.4.2.6 Situation Without Condition Tolerances

If the total ESP measured after setting airflow exceeds the adjusted total ESP requirement determined in accordance with Section 5.17 by more than 0.05 in H_2O because the ESP and airflow requirements cannot be simultaneously met, there is not a condition tolerance for total ESP.

If an airflow less than 97% of the *manufacturer-specified* airflow is used for a test in Section 5.19.4.2.4, there is not a condition tolerance for airflow.

5.19.4.2.7 No Airflow Specified, But Settings Specified

For tests where there is not a *manufacturer-specified* airflow and the cooling *full load rated indoor airflow* is not used as the airflow for the test because there are *manufacturer-specified* fan control settings or instructions to obtain steady-state operation for the test, in accordance with the provisions of Section 5.18, use the *manufacturer-specified* fan control setting for that test condition or allow the system to automatically adjust airflow, as specified in the *MII*. Adjust the airflow-measuring apparatus to meet the adjusted total ESP requirement determined in accordance with Section 5.17 with a condition tolerance of 0.00/+0.05 in H_2O, using the measured airflow in the ESP calculation.

5.20 Setting Indoor ESP and Airflow for Coil-only Indoor Units

Set the airflow within ± 3% of the target airflow. If the maximum pressure drop specified in Section 5.17.2 is exceeded, reduce the airflow until the measured pressure drop equals the specified maximum. Maintain the airflow at this level throughout the test.

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5.21 Outdoor Airflow for Units with Free Air Discharge Condensers

All *standard ratings* shall be determined at the outdoor airflow obtained without condenser ducting. Where the fan drive is non-adjustable, the *standard ratings* shall be determined at the outdoor airflow inherent in the equipment. For adjustable speed fans, the outdoor fan speed shall be set as specified in the *MII* or as determined by automatic controls. Once established, changes affecting outdoor airflow shall not be made unless automatically adjusted by unit controls or adjusted to achieve stability as described in Section E.7.3 or Section E.7.4. Outdoor airflow does not need to be measured unless using the outdoor air enthalpy method in accordance with Section E.6.5.

5.22 Outdoor Airflow and ESP for Units with Ducted Condensers

For *double-duct systems*, rate based on non-zero condenser ESP using the provisions of Section 5.22.1.

For equipment with a condenser fan/motor assembly designed for external ducting of condenser air that is not a *double-duct system* (for example, if the unit does not meet the maximum height or width requirements, or if the unit has a rated *cooling capacity* greater than 300,000 Btu/h), rate based on zero condenser ESP using the provisions of Section 5.22.2.

Note: For equipment with a condenser fan/motor assembly designed for external ducting of condenser air that is not a *double-duct system*, non-standard (for example, higher-static) ducted condenser fans are an optional feature in accordance with Section D.2.1.

5.22.1 Rating Based on Non-zero Condenser ESP

5.22.1.1 Installation and Setup

Install the unit with outdoor coil ductwork and ESP measurements made in accordance with Section 6.4 and Section 6.5 of ASHRAE 37 and manufacturer's instructions as applicable. Set outdoor air ESP by symmetrically restricting the outlet of the outdoor air outlet duct downstream of the minimum duct length specified in Section 6.4.2.1 of ASHRAE 37 (such as at least 2.5 times the mean geometric cross-sectional dimension from the equipment outlet). If using the outdoor air enthalpy method, perform a secondary verification test with the outdoor airflow measurement apparatus attached to the outdoor duct in addition to the outlet duct restrictors (do not adjust the outlet duct restrictors) for full-load cooling and heating tests, as specified in Section E.6.5.2.

5.22.1.2 Full-Load Cooling Test

If manufacturer's instructions provide guidance for setting outdoor airflow (for example, outdoor fan control settings), set the outdoor airflow in accordance with manufacturer's instructions, while maintaining the outdoor air ESP within -0.00/+0.05 in H_2O of 0.5 in H_2O. If manufacturer's instructions do not provide guidance for setting outdoor airflow, test using the as-shipped outdoor fan setting while maintaining the outdoor air ESP within -0.00/+0.05 in H_2O of 0.5 in H_2O. If the outdoor air ESP cannot be maintained within -0.00/+0.05 in H_2O of 0.5 in H_2O at the *manufacturer-specified* or as-shipped fan setting (as applicable), operate with a fan setting as close as achievable to the target fan setting (such as *manufacturer-specified* or as-shipped) so that the outdoor air ESP requirement is met.

5.22.1.3 Heating and Part Load Cooling Tests

Adjustment is not needed to change the outdoor air ESP for heating or part-load cooling tests. If *MII* specify outdoor fan settings for heating or part-load cooling tests or describe how to obtain steady-state heating or part-load cooling operation (for example, using thermostat or other control system input) that results in an automatic adjustment to outdoor airflow, operate at the outdoor airflow resulting from using the *MII*.

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5.22.2 Rating Based on Zero Condenser ESP

5.22.2.1 Installation and Setup

Install the unit with outdoor coil ductwork and external static pressure measurements made in accordance with Section 6.4 and Section 6.5 of ASHRAE 37 and manufacturer's instructions as applicable. The unit shall operate at 0.0 in H_2O external static pressure with a condition tolerance of -0.00/+0.05 in H_2O. If manufacturer's instructions provide guidance for setting outdoor airflow (for example, outdoor fan control settings), set the outdoor airflow in accordance with manufacturer's instructions while maintaining the outdoor air ESP within -0.00/+0.05 in H_2O of 0.0 in H_2O. If manufacturer's instructions do not provide any guidance for setting outdoor airflow, test using the as-shipped outdoor fan setting while maintaining the outdoor air ESP within 0.00/+0.05 in H_2O of 0.0 in H_2O. If the outdoor air ESP cannot be maintained within 0.00/+0.05 in H_2O of 0.0 in H_2O at the *manufacturer-specified* or as-shipped fan setting (as applicable), operate with a fan setting as close as achievable to the target fan setting (such as *manufacturer-specified* or as-shipped) so that the outdoor air ESP requirement is met. Outdoor airflow does not need to be measured unless using the outdoor air enthalpy method in accordance with Section E.6.5.

5.22.2.2 Outdoor Air ESP Tolerance

The outdoor air ESP tolerance of -0.00/+0.05 in H_2O is a condition tolerance that applies throughout the test. Specifically, the average value of the outdoor air ESP measured over the course of the test shall vary from the target value by not more than the condition tolerance. An operating tolerance for ESP is specified in Section 5.25.

5.23 Outdoor Air Water Vapor Content

Outdoor air water vapor content shall be controlled for the following tests.

For cooling tests of air-cooled equipment that use condensate obtained from the evaporator to enhance condenser cooling, and all evaporatively-cooled equipment, entering outdoor air shall be controlled to the wet-bulb temperature requirements in Table 7 and wet-bulb tolerances in Section 5.25.

For cooling tests of air-cooled single package units that do not reject condensate to the outdoor coil, and where all or part of the indoor section of the equipment is located in the outdoor chamber, entering outdoor air shall be controlled to the dew point temperature requirements in Table 7 and dew point tolerances in Section 5.25.

For heating tests of all air-source heat pumps, entering outdoor air shall be controlled to the wet-bulb temperature requirements in Table 23 and wet-bulb tolerances in Section 5.25.

For all other tests, there are not any requirements on outdoor air water vapor content.

5.24 Water Flow Rate for Water-cooled Units

For the full-load cooling test, set water flow rate to meet the required entering and leaving water temperatures.

Except as adjusted for operation at low condenser temperatures in accordance with Section E.7, for part-load cooling tests, use *manufacturer-specified* full-load water flow rates. For all part-load cooling tests, the water flow rate shall not exceed the water flow rate used for the full-load cooling test. If the *manufacturer-specified* part-load cooling water flow rate is higher than the water flow rate used for the cooling full-load test, use the water flow rate used for the cooling full-load test. If no *manufacturer-specified* value for part-load cooling water flow rate is provided, use the water flow rate used for the cooling full-load tests. If using a target water flow rate in part-load tests, the condition tolerance on water flow rate is 1% of the target water flow rate.

5.25 Test Tolerances

5.25.1 Order of Precedence

Tolerances specified in this standard supersede tolerances specified in ASHRAE 37.

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5.25.2 Operating Tolerance

Test operating tolerance is the maximum permissible range that a measurement shall vary over the specified test interval. Specifically, the difference between the maximum and minimum sampled values shall be less than or equal to the specified test operating tolerance. If the operating tolerance is expressed as a percentage, the maximum permissible range is the specified percentage of the average value of the measured test parameter.

5.25.3 Condition Tolerance

Test condition tolerance is the maximum permissible difference between the average value of the measured test parameter and the specified test condition. If the condition tolerance is expressed as a percentage, the condition tolerance is the specified percentage of the test condition.

5.25.4 Table of Tolerances

Test operating tolerances and condition tolerances are specified in Table 6.

Table 6 Tolerances

Measurement	Test Operating Tolerance	Test Condition Tolerance
Outdoor dry-bulb temperature (°F):		
Entering	2.0	0.5
Leaving	2.0 / 3.0[1,2]	—
Outdoor wet-bulb temperature (°F):		
Entering	1.0	0.3[3]
Leaving	1.0[2]	—
Outdoor dew point temperature[4] (°F):		
Entering	—	3.0
Indoor dry-bulb temperature (°F):		
Entering	2.0	0.5
Leaving	2.0 / 3.0[1]	—
Indoor wet-bulb temperature (°F):		
Entering	1.0	0.3[5]
Leaving	1.0	—
Water serving outdoor coil temperature (°F):		
Entering	0.5	0.2
Leaving	0.5	0.2
Water serving outdoor coil flow rate, when flow rate specified (percent)	2.0	1.0
Makeup water temperature (°F):	10.0	5.0
Saturated refrigerant temperature corresponding to the measured indoor side pressure[6] (°F)	3.0	0.5
Liquid refrigerant temperature[6] (°F)	0.5	0.2
External static pressure (in H_2O)	0.05	See Section 5.19

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Measurement	Test Operating Tolerance	Test Condition Tolerance
Return static pressure	—	See Section 5.17.1.4
Electrical voltage (percent of reading)	2.0	1.0
Electrical Frequency (Hz)[7]	0.4	0.2
Water flow rate (percent of reading)	2.0	See Section 5.24
Nozzle pressure drop (percent of reading)	2.0	—

Notes:

1. The test operating tolerance is 2.0°F for cooling tests and 3.0°F for heating tests.
2. Applies only when using the outdoor air enthalpy method.
3. Applicable for heating tests of air-cooled units and only applicable for cooling tests when testing evaporatively-cooled equipment or, air-cooled equipment that rejects condensate to the outdoor coil. See Section 5.23.
4. Applicable only when testing single package units that do not reject condensate to the outdoor coil where all or part of the indoor section of the equipment is located in the outdoor chamber. See Section 5.23.
5. Applicable only for cooling tests.
6. See Section 5.25.5.
7. When using electrical generators, tolerances can be doubled.

5.25.5 Refrigerant Temperatures

Tolerances on saturated refrigerant temperature and liquid refrigerant temperature apply only for the compressor calibration and refrigerant enthalpy methods. The saturation temperature, in this case, shall be evaluated based on the pressure transducer located between the indoor coil and the compressor for the given operating mode, heating or cooling.

Section 6. Rating Requirements

6.1 Standard Ratings

Use the requirements of Section 6 to determine all *standard ratings*. Perform all tests using the requirements of Section 5.

6.1.1 Criteria for Standard Ratings

Standard ratings shall meet the following criteria:

- Standard cooling ratings shall be established at the *standard rating conditions* specified in Table 7 for North American ratings, or Appendix F for *international ratings*.
- Standard heat pump (HP) heating ratings shall be established at the *standard rating conditions* specified in Table 23.
- *Standard ratings* related to *cooling* or *heating capacities* shall be net values, including the effects of circulating fan heat.
- *Standard ratings* shall be based on the total power input (see Appendix D regarding features to be included and activated during the test). Power used for any override controls only used for laboratory testing shall not be included in total power.
- *Standard ratings* shall be based on 100% recirculated indoor air.

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